WARNING: You must return this section with your answer book otherwise marks will be lost.

Write Your Examination Number here

AN ROINN OIDEACHAIS

LEAVING CERTIFICATE EXAMINATION, 1995

PHYSICS — HIGHER LEVEL

THURSDAY, 15 JUNE — AFTERNOON 2.00 to 5.00

Answer **all** questions in Section A.

Answer **two** questions from Section B and **three** questions from Section C.

SECTION A (120 marks)

1. Answer *five* of the following items, (i), (ii), (iii), etc. In the case of each item write the letter corresponding to the correct answer in the box provided.

(i) The unit of energy, the joule, is equivalent to

A. $N\ m^{-2}$
B. $N\ m^{-1}$
C. $N\ m$
D. $N\ m\ s^{-1}$
E. $N\ m\ s^{-2}$.

Answer ☐ (6)

(ii) A simple harmonic motion is described by the equation $a = -4x$. The period of this motion is

A. 8π
B. 4π
C. π
D. $\pi/2$
E. $\pi/8$.

Answer ☐ (6)

(iii) Which of the following statements concerning the transfer of heat is *not* correct?

A. Convection may take place in liquids and gases.
B. Conduction and convection may take place in solids.
C. Conduction may take place in solids and liquids.
D. Convection and radiation may take place in gases.
E. Radiation and conduction may take place in solids.

Answer ☐ (6)

(iv) The natural frequency of a stretched string is

A. proportional to its tension and inversely proportional to its length
B. proportional to the square root of its tension and inversely proportional to its mass per unit length
C. proportional to its tension and inversely proportional to the square root of its mass per unit length
D. proportional to its tension and inversely proportional to the square root of its length
E. proportional to the square root of its tension and inversely proportional to its length.

Answer ☐ (6)

(v) In a bi-polar transistor in a common-emitter circuit the

A. base current is controlled by the collector current
B. base current is controlled by the emitter current
C. collector current is controlled by the emitter current
D. collector current is controlled by the base current
E. emitter current is controlled by the collector current.

Answer ☐ (6)

(vi) In a nuclear reactor the purpose of the control rods is to control

A. the speed of the neutrons
B. the number of neutrons causing fission
C. the kinetic energy of the neutrons
D. the supply of U–235
E. the supply of U–238.

Answer ☐ (6)

2. Answer *five* of the following.

(i) The sum of the .....energy and the energy .....

of a freely falling body is constant. (6)

(ii) State Avogadro's law.....

..... (6)

(iii) When the sound intensity at a point increases by a factor of 400 the relative increase in intensity in decibels is

..... (6)

(iv) Give an expression for Coulomb's law of force between electric charges. ..... (6)

(v) The angle of dip is the angle between the .....

.....and the ..... (6)

(vi) What is meant by the electrochemical equivalent of an element?.....

.....(6)

3. Answer *five* of the following.

(i) Give an equation which defines temperature on the Celsius scale.....

..... (6)

(ii) According to the kinetic theory of gases the average kinetic energy of the .....

of a gas is proportional to the ..... of the gas. (6)

(iii) The thermometric property on which the constant volume gas thermometer is based is .....

..... (6)

(iv) The triple point of water is the temperature at which .....

..... (6)

(v) Using the axes shown in Fig. 1 sketch a graph to illustrate the variation of the resistance of a metallic conductor with temperature. (6)

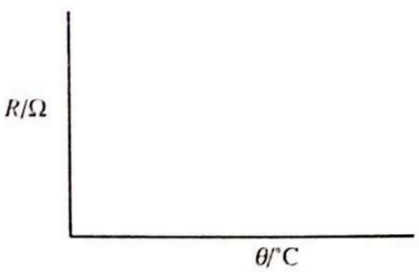

Fig. 1

(vi) The surface of a metal at a high temperature may emit electrons. This phenomenon is called.....

.....and it is applied in the .....tube. (6)

4. Answer *five* of the following.

(i) What is meant by electromagnetic induction? .....

..... (6)

(ii) The laws of electromagnetic induction were discovered by .....in the early

part of the .....century. (6)

(iii) The peak value of an a.c. voltage is 14 V. What is the r.m.s. value of the voltage? .....

..... (6)

(iv) What is meant by self-inductance?.....

..... (6)

(v) Give one way in which energy losses may be reduced in a transformer.....

..... (6)

(vi) When a magnet is moved over a sheet of aluminium the sheet of aluminium will tend to follow the magnet.

Name a device which is based on the principle illustrated by this phenomenon.....

..... (6)

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PHYSICS — HIGHER LEVEL

Section A is on a separate sheet which provides spaces for your answers. The completed sheet should be enclosed in your answer book.

Write your answers to Sections B and C in your answer book.

SECTION B (80 marks)

Answer **two** of the questions from this section.

Each question carries the same number of marks.

5. In an experiment to verify the principle of conservation of momentum a body, A, was set in motion with a constant velocity. It was then allowed to collide with a second body, B, which was initially at rest. After the collision the two bodies moved together with the same velocity. The time, t_1, taken by A to travel a distance of 20 cm immediately before the collision was found. The time, t_2, taken by A and B to travel a distance of 20 cm immediately after the collision was also found. The masses of A and B were changed and the experiment repeated. The results obtained are shown in the table.

Mass of A/g	Mass of B/g	t_1/s	t_2/s
200	220	0.20	0.42
200	320	0.14	0.36
300	420	0.16	0.38

Use the data given in the table to show how this experiment verified the principle of conservation of momentum. (15)

Describe the apparatus which might have been used in this experiment. (9)

Explain how the time might have been measured. (9)

Give one precaution which might have been taken to improve the accuracy of this experiment. (6)

6. The following is part of a student's account of an experiment to determine the specific latent heat of vaporisation of water.

"Some water was cooled below room temperature and placed in a copper calorimeter. Steam was then generated and passed into the water in the calorimeter."

Draw a labelled diagram of the apparatus which might have been used in this experiment. (6)

Explain why cooling the water used in the calorimeter to below room temperature could have led to a more accurate result and give one other precaution which might have been taken to improve the accuracy of the experiment. (9)

Explain how the mass of the steam would have been determined and give the other measurements which would have been taken. (15)

Give the equation which would have been used to calculate the specific latent heat of vaporisation of water. (9)

12. What is (i) a semiconductor, (ii) a photon? (12)

Describe an experiment to plot the characteristic curve of a diode. (18)

Fig. 5 shows a photodiode connected in series with a battery and a galvanometer, G. What is the function of the battery in this circuit? Why is it not necessary to have a resistor in series with the photodiode as it would be for a light-emitting diode (LED)? (9)

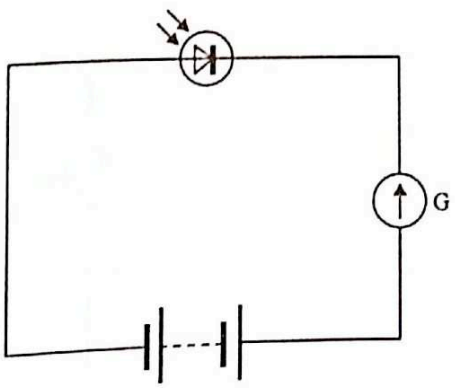

Fig. 5

State the relationship between the intensity of the light falling on the photodiode and the current flowing through the galvanometer. Explain how this relationship arises. (12)

Light energy falls on the photodiode at a rate of 0.24 mW. The light is monochromatic and of wavelength 6.0×10^{-7} m. Calculate (i) the energy of one photon of the light, (ii) the number of photons striking the photodiode surface per second. (15)

(Speed of light in vacuum, $c = 3.0 \times 10^8$ m s^{-1}; Planck's constant, $h = 6.6 \times 10^{-34}$ J s.)

13. Answer any *two* of the following.

(a) State Newton's Universal Law of Gravitation. (6)

A satellite is in a circular orbit of a given radius around a planet. Show that the speed of the satellite is proportional to the square root of the mass of the planet and independent of the mass of the satellite. (15)

One of the moons of Saturn is in an orbit which has approximately the same radius as that of the earth's moon. Given that the speed of the Saturn moon is 10 times the speed of the earth's moon calculate a value for the mass of Saturn. (Mass of earth = 6.0×10^{24} kg.) (12)

(b) State the laws of refraction of light. (6)

Describe an experiment to measure the focal length of a converging lens. (12)

Use a ray diagram to show how the final image is formed in a compound microscope or an astronomical telescope. (15)

(c) Define the term electric field intensity. (6)

Outline the principle of operation of a Van de Graaff generator. If a pointed object is attached to the dome of the generator it will no longer be possible to charge the dome to as high a voltage. Explain. (18)

The dome of a Van de Graaff generator is a sphere of radius 16 cm and carries a charge of 2.3 μC. Calculate the electric field intensity at the surface of the dome. (Permittivity of free space, $\varepsilon_0 = 8.9 \times 10^{-12}$ F m^{-1}.) (9)

(d) State Joule's law. (6)

Explain why it is more economical to transmit electrical energy at high voltages. Why is a.c. more suitable for this purpose than d.c.? (18)

Discuss the safety features which are included in domestic circuits. (9)

7. In an experiment to determine the half-life of a short-lived radioactive isotope a measure of the activity, A, for a sample of the isotope was obtained at various times t. The following results were recorded.

t/s	0	20	40	60	80	100	120	140	160
A/Bq	60	45	35	26	20	17	13	10	7

Draw a suitable graph on graph paper to illustrate the change in activity with time and, from the graph, determine the half-life of the isotope. (21)

Describe the apparatus which might have been used in this experiment. (12)

Give two safety precautions which should be observed when handling radioactive materials. (6)

SECTION C (200 marks)

Answer **three** questions from this section.

Each question carries the same number of marks.

8. Explain the terms (i) limiting friction, (ii) coefficient of static friction. (9)

State Newton's second law of motion and show how this leads to the expression $F = ma$. (15)

Describe an experiment to measure the coefficient of dynamic friction. (18)

A car of mass 1200 kg is towing a trailer of mass 400 kg at a constant speed of 20 m s^{-1}. The trailer has no brakes. Assume that the frictional forces on the trailer are negligible and that the trailer does not affect the frictional forces which are acting on the car. If the maximum coefficient of friction between the wheels of the car and the road is 0.4 calculate:

(i) the shortest distance in which the car and trailer can be brought to rest;

(ii) the average magnitude of the force exerted by the trailer on the car while they are coming to rest. (Acceleration due to gravity, $g = 9.8$ m s^{-2}.) (24)

9. Sound and light are both wave motions. Give two differences between sound waves and light waves. (6)

Describe a laboratory experiment to measure the speed of sound in air. (18)

When monochromatic light falls on a diffraction grating a series of bright images may be seen. Explain fully how these images are produced. (15)

Explain the principles involved in each of the following.

(i) Two tuning forks are fixed side by side. One is set vibrating and then stopped. The other is then found to be vibrating. (9)

(ii) Fig. 2 shows two sheets, A and B, of a certain type of transparent material placed parallel to each other in front of a light source, S. A is fixed and B can be rotated on its stand while being kept parallel to A. It is observed that when B is rotated through 90° no light passes through the two sheets of material. (9)

(iii) When white light is passed through a prism a spectrum is obtained. (9)

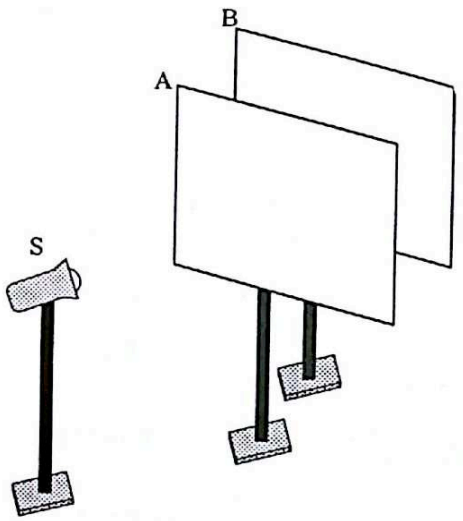

Fig. 2

10. Define resistivity. (6)

Describe an experiment to determine the resistivity of the material of a wire. (18)

The current flowing from A to B through resistor R in Fig. 3 is 0.4 A. Use Kirchhoff's laws to calculate the resistance of R. Assume that the internal resistances of the batteries are negligible. (24)

Draw a circuit diagram for an ohmmeter and explain how it works. (18)

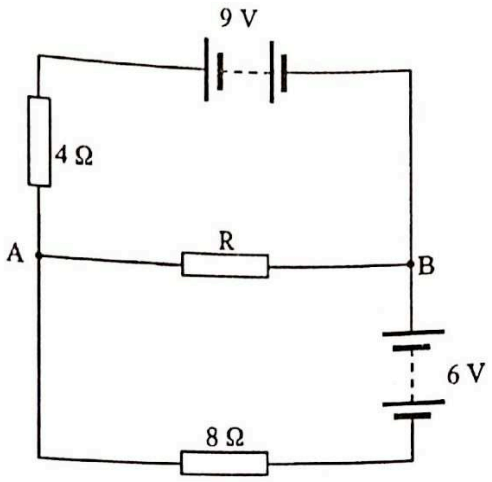

Fig. 3

11. Define the term magnetic flux density. (6)

Describe an experiment to show that a current-carrying conductor in a magnetic field experiences a force. (15)

Draw a labelled diagram of a moving-coil loudspeaker. (15)

Fig. 4 shows a rectangular loop of wire which is free to rotate about an axis parallel to its longer sides. The plane of the loop is parallel to a uniform magnetic field of magnetic flux density B. The dimensions of the loop are 20 cm by 15 cm and the direction of B is perpendicular to the longer sides. The magnitude of B is 0.44 T and a current of 2.6 A flows around the loop. Calculate:

(i) the magnitude of the force acting on one of the longer sides of the loop; (12)

(ii) the moment of the force about the axis. (9)

Explain why the moment of the force decreases as the loop turns through 90° about the axis from the position shown. (9)

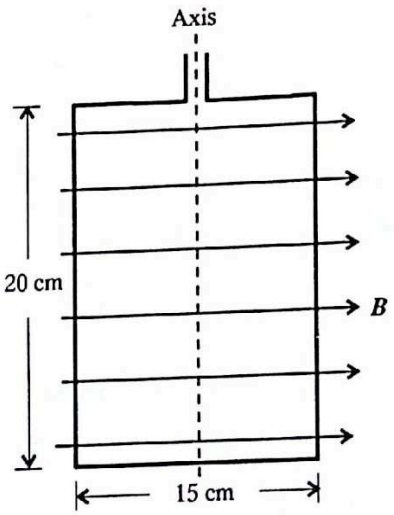

Fig. 4